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The Usage of Self-Regulated Learning Strategies among Form Four Students in the Mathematical Problem-Solving Context: A Case Study

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Abstract

This paper presents findings on the self-regulated learning strategies among Form Four students in the State of Perak, Malaysia. A case study was used to determine the usage of self-regulated strategies among the students and how it helps the students in solving Mathematics' problems. Besides that, the level of motivation among the students is also identified. Data has been collected through Motivated Learning Strategies Questionnaire-Revised (MSLQ-R), reviewing of written answers of students (tests) and interviews. The research revealed the level of motivation and the existence of self-regulated learning strategies among the students. This research has shown that there is a strong relationship between the self-regulated learning strategies and the students' performance of problem-solving.

Keywords: Self-regulated learning; Problem solving strategies; Motivation

1. Introduction

Self-regulated is an integrated learning process, which consists of behaviour growth that affects students' learning. The learning process is planned and adjusted according to the students' objective, so that changes will be made in the learning situation. In other word, self-regulated can be used to describe learning that is guided by metacognition, strategic action (planning, monitoring and evaluating personal progress against a standard) and motivation to learn (Butler & Winne, 1995; Winne & Perry, 2000; Perry, Phillips & Hutchinson, 2006; Zimmerman, 1990).

In particular, self-regulated learners are cognizant of their academic strengths and weaknesses, and they have a repertoire of strategies they appropriately apply to tackle the day-to-day challenges of academic tasks (Dweck & Leggett, 1988; Dweck, 2002). Problem-solving used needs to be hands-on and minds-on activity. Hence, the mathematical activity should be problem-solving in its orientation so that an active learning environment among the students will be promoted.

This research is conducted in order to identify the usage of self-regulated learning (SRL) strategies among Form Four students in mathematical problem solving context. The emphasis is on mathematical problem solving where researcher can identify the ability of students in applying certain skills to solve the problems. Students with strategies are able to solve problems, hence their test performances are better and therefore, researcher can identify the availability of motivation as well as strategies that were being practiced by the students.

A review of the literature shows that most of the self-regulated learning studies conducted so far have highlighted on the effect of each SRL components on students' learning. According to Eide, 1999; Pokay & Blumenfeld-Phyllis, 1990, most of the studies have reported on metacognitive aspect which is related to one's action. The other study stated that effort management had a positive effect on academic performance (Doljanac, 1994; Lee, 1997). On the other hand, Chalupa and Chen (*in press*) and Hsu had identified that

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resource and management strategies did not have an effect on academic performance. Studies had also been done to see the relationship between academic performance and the usage of self-regulated learning strategies. According to Pintrich & De Groot (1990) and Van Zile-Tamsen & Livingston (1999), a high achiever students had used more SRL compared to low achiever students. In Malaysia, a review of the literature on learning shows that there are hardly any documented records of studies on students' use of SRL in the specific domain or learning tasks in general. One study had been done on 270 students of University Putra Malaysia (UPM) in order to identify the relationship of intrinsic goal orientation and extrinsic goal orientation with learning strategies. Findings showed that both goal orientations had positive and significant relationship towards learning strategies. The other study on 312 students of secondary school in Kuching was to identify the use of SRL strategies in learning science. According to Mary Wong Siew Lian and Siew Heng Yoke, the use of SRL strategies in learning science was moderate. Students appeared to mention the use of strategies such as seeking information, self-environment structuring, physical environment structuring, rehearsing and seeking peer assistance more than self-check, reviewing notes and completed work, self-consequating, organizing information and seeking other social assistance. Therefore, there is a need for studies to explore students' use of SRL strategies in specific domain or learning tasks. This was the main aim of the present study.

This study was carried out in order to get a clear view on the usage of self-regulated learning strategies among Form Four students. Specifically, this study aimed to:

a) Identify the level of motivation among Science Stream Form Four students.
b) Identify the self-regulated learning strategies which are used by Science Stream Form Four students in learning Mathematics.
c) Identify the level of Mathematical problem-solving strategies among the students based on the given test.

2. Significance of the Study

In Malaysia, the education of Mathematics aims to develop individuals who are able to think mathematically and who can apply mathematical knowledge effectively and responsibly in solving problems and making decision (Ministry Of Education Malaysia). Through this study, the usage of self-regulated learning strategies among students can be identified. Therefore, teachers who are part and parcel of the education system, have a role of facilitating students' learning. Teacher as facilitator should be able to raise up students' skills of learning, so that students' understandings will be increased. Next, teachers also should enhance their teaching techniques to identify students' weaknesses especially in mathematical problem-solving. Based on the findings, it will also help students to realize the importance of applying appropriate self-regulated learning strategies to enhance their academic performance.

3. Limitations Of The Study

As in most studies on student learning, generalization of the findings to other contexts is limited by educational and cultural differences. The findings in this study can only be generalized to coeducational government secondary school in Perak, Malaysia. Students in similar schools in other parts of Malaysia may differ with respect to their educational background and diversity. The strategies identified here are specifically on students' learning of Mathematics and therefore cannot be generalized to students' learning of other subjects such as Science, History or English. Researchers (Alexander, 1995; Boekaerts, 1995) have stressed that SRL is domain specific and likely to be influenced by subject-matter knowledge and interest.

4. Methodology

Participants

The sample included 249 students of Science Stream Form Four students. The students were randomly selected from four government secondary schools in Kinta Utara District, Perak. The justifications of choosing those students are based on the equality in the classroom environment physically, emotionally and culturally, and also from different background and the level of academic performance in Mathematics.

Instrument

A survey questionnaire that is *Motivated Learning Strategies Questionnaire-Revised* (MSLQ-R), which required students to respond to 74 items on students' motivation, strategies and their learning skills in their classrooms was used. MSLQ-R was used to gather information on students' frequency of use of self-regulated learning strategies. The MSLQ-R was a structured format where students had to mark their priority of learning context, coded 1 = '*tidak benar sama sekali untuk diri saya*', 2, 3, 4, 5, 6, 7 = '*sangat benar sama sekali untuk diri saya*'.

Next, the students were given a test on Mathematical problem-solving. The test consists of nine items from three topics that are *"Trigonometry", "The Straight Line"* and "Circles III". Each items required certain skills, hence certain strategies should be applicable. Therefore, the ability of students to solve the Mathematics' problems showed that they had their own learning strategies. Then, a semi structured interview was used to obtain clearer responses about students' self-regulated learning. The interview was taken on 12 selected students where its information supported the results from the two previous instruments; that were questionnaire and performance test. The collected data was analysed with Statistical Package for Social Science (SPSS), where the data was interpreted as descriptive and inferential statistics.

5. Findings and Discussion

5.1 Level of Motivation among Science Stream Form Four Students towards Learning Mathematics

Table 1: The Mean and Standard Deviation of Motivation Level of Form Four Science Stream Students

Aspect	Mean	Standard Deviation
Motivation	5.45	0.624

Items 1 through 28 in a survey questionnaire about the students' motivation in learning Mathematics was analysed. Findings show that the mean for motivation is 5.45 (SP = 0.624). According to three level of motivation; coded low motivation : 1.0 - 2.9, medium motivation : 3.0 - 4.9 and high motivation : 5.0 - 7.0. Hence, findings fall under high motivation. This findings show that the Science Stream Form Four students' motivation is high towards learning Mathematics.

The analysis of item 1 to 28 was detailed where it focuses on three components of motivation that are adhered value, expectancy and affective.

Table 2: The Mean and Standard Deviation of Motivation Level of Form Science Stream Form Four Students Based on Component

Components	Mean	Standard Deviation
Adhered Value	5.69	0.744
Expectancy	5.28	0.634
Affective	5.00	1.297
Total Score	5.45	0.624

The findings show that adhered value component has positive mean score 5.69 (SP = 0.744), whereas expectancy and affective components give negative mean scores 5.28 (SP = 0.634) and 5.00 (SP = 1.297) respectively. As a conclusion, the analysis states that Science Stream Form Four students prefers to have high motivation in adhered value components compared to expectancy and affective components.

Next, the adhered value component was analysed according to three categories that are intrinsic goal orientation, extrinsic goal orientation and task value.

Table 3: The Mean and Standard Deviation of Motivation Level of Science Stream Form Four Students Based on Categories

Categories	Mean	Standard Deviation
Intrinsic Goal Orientation	5.09	0.889
Extrinsic Goal Orientation	6.22	0.840
Task Value	5.85	1.000
Total Score	5.69	0.744

The findings show that two categories that are extrinsic goal orientation and task value of Science Stream Form Four students towards learning Mathematics have positive mean scores 6.22 (SP = 0.840) and 5.85 (SP = 1.000) respectively. Whereas intrinsic goal orientation has negative mean score 5.09 (SP = 0.889). In conclusion, Science Stream Form Four students prefer to have high motivation from the aspects of extrinsic goal orientation and task value throughout the Mathematics learning.

5.2 Self-Regulated Learning Strategies that Science Stream Form Four Students used in learning Mathematics

The items in a survey questionnaire from 29 to 74 asked on Form Four students' learning strategies towards Mathematics were analysed.

Table 4: The Mean and Standard Deviation of Science Stream Form Four Students' Learning Strategy

Aspect	Mean	Standard Deviation
Learning Strategy	4.35	0.683

The findings show that the mean score for learning strategic is 4.35 (SP = 0.683). Based on the three level of strategic; coded low strategic: 1.0 -2.9, medium strategic: 3.0 – 4.9 and high strategic: 5.0 – 7.0, then its mean score falls under medium strategic. In conclusion, Science Stream Form Four students have medium learning strategic towards Mathematics.

Next, those items was analysed in detailed according to three components that are cognitive and Meta cognitive strategies, resource and management strategies and trouble shooting.

Table 5: The Mean and Standard Deviation of Science Stream Form Four Students' Learning Strategy based on Components

Components	Mean	Standard Deviation
Cognitive and Metacognitive Strategies	4.19	0.807
Resource and Management Strategies	4.43	0.672
Trouble Shooting	5.65	1.102
Total Score	4.35	0.683

Findings show that two components that are resource and management strategies and troubleshooting give positive mean scores 4.43 (SP = 0.672) and 5.65 (SP = 1.102) respectively, whereas cognitive and meta cognitive strategies give a negative mean with score 4.19 (SP = 0.807). In conclusion, Science Stream Form Four students prefer to practice resource and management strategies and troubleshooting compared to cognitive and meta cognitive strategies.

Next, the resource and management strategies were analysed according to four categories; that are time and study environment, effort regulation, peer learning and help seeking.

Table 6: The Mean and Standard Deviation for Resource and Management Strategies of Science Stream Form Four Students' Learning Strategy based on Components

Categories	Mean	Standard Deviation
Time and Study Environment	4.72	0.820
Effort Regulation	4.14	1.917
Peer Learning	3.85	1.252
Help Seeking	4.64	1.245
Total Score	4.43	0.672

Findings state that two categories; time and study environment and help seeking have positive mean scores 4.72 (0.820) and 4.64 (SP = 1.245) respectively. The other two categories that are effort regulation and peer learning have negative mean scores 4.1 (SP = 1.917) and 3.85 (SP = 1.252) respectively.

The analysis shows that Science Stream Form Four students prefer to practice the resource and management strategies from the aspects time and study environment and help seeking when facing with problems in their Mathematics' learning. Hence, the analysis also shows that the students have less effort regulation and peers learning.
Next, the third strategic component that is trouble shooting was analysed according to three items; 61, 64 and 71.

Table 7: The Mean and Standard Deviation for Trouble Shooting Component of Science Stream Form Four Students' Learning Strategy based on Items

Item of Trouble Shooting	Mean	Standard Deviation
61	5.84	1.639
64	5.17	1.490
71	5.96	1.194
Total Score	5.65	1.102

Findings show that two items 61 and 71 have positive mean scores 5.84 (SP = 1.639) and 5.96 (1.194) respectively; whereas item 64 has a negative mean score 5.17 (SP = 1.490). Based on questionnaire analysis, item 61 asked *"Usually I will study in a place where it will help me focus my attention on my assignment"* and item 71 asked *"I will seek help from my classmates when I don't understand the content of the subject that I have been taught"*. Analysis shows that Science Stream Form Four students have effort to overcome their learning's problems whereby the students focus on time and study environment and help seeking.

5.3 Relationship between Motivation and Learning Strategies

The data was analysed as inferential statistics whereby its correlation coefficient, r = 0.49. The result shows that there is a significant relationship between motivation and learning strategies. Hence, if the students' motivation is high, then the students' learning strategies are also high. However, the relationship of two variables is weak. The correlation is significant at probability value, $p < 0.01$.

5.4 Level of Mathematical Problem-solving Strategies based on the given test

The data was analysed as descriptive statistics whereby its mean score is 32.2 (S.D = 24.44). Based on the coded skills' levels, that are low skills : 0 - 29, medium skills : 30 - 59 and high skills : 60 - 90; findings show that the students' skills in mathematical problem-solving are medium. Hence, students' understandings of the problem, their strategic planning and carrying out the strategic are medium.

The results explained that the medium usage of learning strategies among the students lead to medium skills in solving Mathematics' problems. As a conclusion, the students must have effective learning strategies in order to acquire excellent test's results

5.5 Interviews with Science Stream Form Four Students

Researcher had linked the analysed data of survey questionnaire and test in detailed with the data from the interviews. The information from interviews supported the previous analysed data whereby there are self-regulated learning strategies among Science Stream Form Four students towards Mathematics especially in problem-solving context. The findings from protocol interviews stated that the percentage of motivation's components is 45% to 100%, whereas the percentage of strategic component is between 20% to 100%.

For motivation, the percentages of each components intrinsic goal orientation, extrinsic goal orientation, task value, control of learning belief, self-efficacy for learning and performance and test anxiety are 100%, 100%, 58%, 92%, 75% and 45% respectively. The findings show that the students gave positive responses towards motivation. Hence, the students have a high motivation in Mathematics' learning especially in terms of intrinsic goal orientation, extrinsic goal orientation, control of learning belief and self-efficacy for learning and performance; whereas the students have medium motivation in the aspects of task value and test anxiety.

Next, for strategies, the components are rehearsal, elaboration, organization, critical thinking, meta cognitive self–regulation, time and study environment, effort regulation, peer learning and help seeking. The percentages for each components are 83%, 67%, 67%, 42%, 83%, 58%, 50%, 20% and 100%. Overall, the findings show the availability of learning strategies among the students in Mathematics.

In conclusion, from the interviews' analysis, it showed that most of the students have motivation and strategies in learning Mathematics. However, there are certain constraints where the students still have test anxiety, lack of peer learning and critical thinking during Mathematics' learning.

6. Conclusion

This case study set out to explore the usage of self-regulated learning strategies among Form Four Students in Mathematical problem solving context. Analysis of students' responses to 74 items of self-regulated learning strategies' questionnaire, nine items of Mathematical problem solving and interviews were identified. Generally, the students did have motivation and certain strategies during Mathematics' learning process. For motivation, most of the students gave more credit to the adhered value; in terms of extrinsic goal orientation and task value. Then, for strategy, most of students seem to practice the resource and management strategies where they agree on time and study environment and help seeking. Hence, to overcome their learning problems, students' responses are towards those two aspects. Furthermore, most of students do not agree with peer learning and they still lack of effort regulation. As for Mathematical problem solving, the students with strategies seem to have better performance in their test compared to those who do not have the strategies. The students are able to apply appropriate skills in solving the problem, showed that they have strategies.

In conclusion, Science Stream Form Four Students have motivation as well as strategies. The students seem to expose to certain strategies only, however they also have other strategies. Meaning that, most of the time the students maybe not be alert to the existing strategies, hence teachers should play their role to raise the awareness of students of the importance of self-regulated learning strategies.

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